Clinical Biochemistry

Interpretation and Applications

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FIRST EDITION

Normal laboratory values

(Blood [B], Plasma [P], Serum [S], Urine [U]).
Major chemical constituents of blood, plasma, urine, spinal fluid, amniotic fluid or serum (Values vary with method used).

Determination	Normal values(values vary with procedure used)
Acetone bodies [P].	0.3-2mg/dL
Adrenocorticotrophic hormone(ACTH)[P].	10-80 ng/L
Alphafetoprotein (AFO)[S].	<10 μg/L
Aldosterone: recumbent.[P]	100-500 pmol/L ,1-8 ng/dL
Amino acid nitrogen[P].	3-5.5 mg/dL
Aspartate aminotransferase (AST;SGOT)[S].	6-25 IU/L at30 C°
Alanine aminotransferase(ALT;SGPT)[S].	3-26 IU/L at30 C°
Ammonia[B].	10- 110 μg/dL (SI:12-65 μmol/L)
Amylase [S].	80-180 units/dL
α_1-Antitrypsin [S].	>180 mg/dL
Ascorbic acid [P].	0.4-1.5 mg/dL (23-85μmol/L)
Bicarbonate (S).	24-28 meq/L (24-28 mmol/L)
Bilirubin [S] -Total: -Direct(conjugated): -Indirect:	 -1.1-1.2 mg/dL (3.5-19μmol/L) -0.1-0.4 mg/dL (<7μmol/L) -0.2-0.7 mg/dL (<12μmol/L)
Bromsulfophthalein(BSP) [S].	<5% after 54 minutes.
Calcium [S].	8.5-10.3 mg/dL (2.1-2.6 mmol/L)
Calcium, ionized [S].	4.25-5.25 mg/dL(1.05-1.3mmol/L)
Catecholamines ,total.[U]	<100μg/24hr.
β-Carotene [S].	50-300 μg/dL (0.9-5.58 μmol/L)
Ceruloplasmin [S].	25-43 mg/dL(1.7-2.9 μmol/L)
Chloride [S or P].	96-106 meq/L(96-106 mmol/L)
Chloride [Sf].	120-132 meq/L(120-132mmol/L.)
Chloride [sweat].	5-40meq/L(5-4 mmol/L)
Cholesterol [S or P].	150-280 mg/dL(3.9-6.85 mmol/L)
Cholesterol esters [S].	65-75% of total cholesterol.
Co_2 content [S or P].	24-29 meq/L.(24-29 mmol/L)
Copper [S or P].	100-200 μg/dL (16-31μmol/L)
Cortisol [P].	5-25μg/dL (138-690 nmol/L).
Creatine phosphokinase(CPK) [S].	10-50 IU/L at 30 °C
Creatine phosphokinase isoenzyme[CK-MB].	<6 U/L.
Creatinine [S or P].	0.7-1.5 mg/dL(62-132 μmol/L)
Creatinine Clearance[S,U].	-Males 105 ± ml/min. -Females 97 ± 20ml/min.
Creatinine[Af].	>2.0 mg/dL taken as sign of maturity.
Cyanocobalamin [S].	200 pg /mL. (148 pmol/L)

Determination	Normal values(values vary with procedure used)
Electrophoresis.[S]. -Albumin -α_1-Globulin -α_2-globulin -β-globulin -γ-globulin	 -3.5-5.2gm/dL.(35-52 gm/L). -0.1-0.4gm/dL.(1-4 gm/L). -0.5-1.0 gm/dL.(5-10 gm/L). -0.6-1.2gm/dL.(6-12 gm/L). -0.6-1.6gm/dL.(6-16 gm/L).
Epinephrine [P].	< 100pg/mL.(<550pmol/L)
Estriol. 3rd trimester [S]. -Uncongugated [S]. -total.[S] - Estriol(pregnancy) [U].	 -5-40 ng/ml,(17-140nmol/L). -40-500ng/ml,(140-1750nmol/L). - at term, 14-44 mg/24hr.(49-154 μmol/24hr)
Ferritin [S].	-Adult women, 20-120 ng/mL. -Men,30-300 ng/mL. -Child to 15 years, 7-140 ng/mL.
Follicle-stimulating hormone(FSH)[P]	-Adult males 2-10U/L -Females:follicular phase 2-8 U/L -Females:post-menopausal > 15 U/L
Folic acid [S] Folic acid [RBC]	-2-20 ng/mL. (4.5-45 nmol/L) ->140 ng/mL (>318 nmol/L)
Glucose [S or P] fasting true. Glucose [Sf].	65-110 mg/dL (3.6-6.1 mmol/L) 40-70 mg/dL,(2.2-3.9 mmol/L).
Growth hormone	-Following glucose load < 2mU/L -Following stress > 20 mU/L
γ-Glutamyl transpeptidase.or transferase[S]	-Males,<30mU/mL at 30 °C -Females,<25mU/mL at 30 °C -Adolescents, <50mU/mL at 30 °C -< 60 IU/L
Haptoglobin [S]	40-170 mg of hemoglobin-binding capacity
Haemoglobin[B]	-Males 13-18 g/dL -Females 12-16 g/dL
Hydrogen ion:arterial blood[B]	35-46 nmol/L (PH 7.36-7.44)
Human chorionicgonadotropine(hCG)[S]. -Nonpregnancy. -Pregnancy.	-0-10 mU/mL. ->30mU/mL.
Insulin [P]. Insulin:in hypoglycaemia[P].	-<860 pg/mL.(<860 ng/L) -< 20 pmol/L
Iodine[S].	3-6.5 μg/dL
Iodine, protein-bound[S].	4-8 μg/dL
Iron [S].	50-175 mg/dL (9-31.3 nmol/L)
Iron-binding capacity [S].	-Total 250-410 μg/dL (44.7-73.4.3 μmol/L) -Percent saturation, 20- 55%.

Determination	**Normal values(values vary with procedure used)**
17-Ketosteroids(17-KS)[U].	-Male 8-20 gm/24hr. -Female 5-15 mg/24hr. -Children <2mg/24hr.
Lactate [B].	Venous, 4-16 mg dL (o.44-1.8 mmol/L)
Lactate dehydrogenase(LDH) [S].	55-140 IU/L at 30 °C.
Lipase [S]	0.2-1.5 U/L.
Lipid fractions [S or P]	-HDL Cholesterol, >40mg/dL. -LDL Cholesterol, <180mg/dL. -VLDL Cholesterol, >40mg/dL.
Lipid, Total [S]	450-1000mg/dL (.5-10 g/L).
Luteinizing hormone (LH):	-Adult males 2.0-10 U/L -Adult females: Follicular phase 2.0-10 U/L Post-menopausal >20 U/L
Magnesium [S or P]	1.8-3 mg/dL.(0.75-1.25 mmol/L)
Metanephrines [U].	0.3-0.9 mg/24hr.
5'-Nucleotidase.(NTP)[S].	0.4-7.0 U/L.
Norepinephrine [P]	< 500pg/mL.(<3nmol L)
Ornithinecarbamoyltransferase(OCT)[S].	0.0-6U/L.
Osmolality [S]	280-296 mosm/kg water (280-296 mmol/kg water). [282-296 mmol/L].
Oxygen - Capacity [B] -Arterial content [B] -Arterial% saturation -Arterial $P_{o2}(P_{ao2})$	-16-24 vol %.values vary with HB.conc. -15-23 vol %.values vary with HB.conc. -94-100% of capacity. -80-100mmHg. Vol %.(11-15 kpa)values vary with age
P_{aCo2} [B arterial]	35-45 mmHg. (4.7-6 kPa)
Parathyroid hormone[S].	10-65 pg/mL (0.10-0.65 ng/mL)
Phenolsulfonphthalein(PSP)[U].	15 min >25% excreted. 30 min >40% excreted.
PH (reaction) [B,arterial]	7.35-7.45 (H^+ 44.7-54.5 nmol/L)
Phosphatase, acid [S]	1-5 units (king-armstrong)
Phosphatase, alkaline [S]	3-15 units (king-armstrong)
Phospholipid[S]	145-200mg/dL
Phosphorus, inorganic [S]	-Adult 3-4.5 mg/dL (1-1.5 mmol/L.) -Children 4.0-7.0 mg dL.(1.28-2.24mmol/L).
Potassium [S or P]	3.5-5 meq/L(3.5-5 mmol/L)

Determination	Normal values(values vary with procedure used)
Protein -Total [S} -Total [Sf] - Total [U]. -Albumin [S] -Globulin [S] -Fibrinogen [P]	-6-8 g/dL.(60-80g/L). -15-4 mg/dL,(150-450 mg/L) -<10 mg/dL,(100mg/dL) -3.5-5.5 g/dL.(35-55g/L). -2-3.6 g/dL.(20-36g/L). -0.2-0.6 g/dL.(2-6g/L).
Pyruvate [B]	0.6-1mg/dL (70-114 μμmol/L)
Renin (plasma renin activity,PRA): recumbent	1.2-2.4 pmol/h/mL
Sodium [S or P]	136-145 meq/L (136-145mmol/L).
Specific gravity [B] Specific gravity [S]	-1.056 (varies with HB & protein conc.) -1.0254-1.0288(varies with protein conc.)
Sulfate[P or S]	0.5-1.5 mEq/L
Testosterone[P]	-Adult males 9-30 nmol/L. -Adult females 0.5-2.5 nmol /L
Thyroid-stimulating hormone(TSH)	0.3-4.0 mU/L
Thyroxin, free[S] Thyroxin binding globuline(TBG),[S] Thyroxine(T_4):total Resin T_3Uptake(RT_3U) RT_3U ratio (TBG assessment)	-0.8-2.4 ng/dL(0.01-0.03ng/L),(9-26 pmol/L) -2-4.8 mg/dL. -60-150 nmol/L -25-36% -0.85-1.15 Ratio.
Triiodothyronine(T_3)[S]	-Total 1.2-2.9 nmol/L -Free 3.0-8.8 pmol/L
Transferrin [S]	200-400 mg/dL(23-45 μmol/L.
Triglycerides [S]	<165mg/dL(1.9 mmol/L)
Blood urea nitrogen Urea nitrogen [S or P]	-8-25 mg/dL(2.9-8.9 mmol/L) -21-53 mg/L(3.5-9 mmol/L)
Uric acid [S or P]	-Men, 3-9 mg/dL(0.18-0.54mmol/L). -Women, 2.5-7.5 mg/dL(0.15-0.45mmol/L).
Urobilinogen. [U]	2 hr: 0.1-1.0 Ehrlich units. 24 hr 0.5-4 Ehrlich units.
Vitamin A [S]	15-60μgm/dL.(0.53-2.1μmol/L0
Vitamin B_{12} [S]	200pg/mL(.148pmol/L)
Vitamin D [S] Cholecalceferol (D_3). -25 hydroxycholecalceferol -1,25-dihydroxycholecalceferol -24,25-dihydroxycholecalceferol	-8-55 ng/mL(19.4-137nmol/L) - 26-65 pg/mL(62-155 pmol/L) -1-5 ng/mL(2.4-12 nmol/L
VMA,4-hydroxy–3-methoxymandelic acid [U]	2-8mg/24hr.(10-40 μmol/24hr.)
Zinc [S]	50-150 μg/dl((7.65-22.95 μmol/L)

Reference Values

Test	Specimen	Value		
		Conventional	SI units	Factor
Acetoacetic acid, qual	U	Negative		
Acetone, qual	U	Negative		
Adrenocorticotropic hormone (ACTH)	P	< 50 pg / ml	< 50 ng/L	1000
Alnine aminotransferase (ALT)	S	3 – 30 U/L	By method described	
Albumin	S	3.5 – 5.2 g/dl	35-52 g/L	10
Aldosterone, upright	P	5 – 20 ng/dl	140-560 pmol/L	27.8
Recumbent	P	1- 8ng/L	28-220 pmol/L	
Amylase	S U	0.8-3.2U/ L Up to 400 U / hr	By method described	
Aspartate aminotransferase (AST)	S	6 – 25 U/L	By method described	
Bicarbonate	P (Art)	21.28 meq / L	21-28 mmol/L	1.0
Bilirubin, total	S	0.1 – 1.0 mg / dl	1.7-17.1umol/L	17.1
Bilirubin, esterified	S	0.0 – 0.3 mg / dl	0-5 umol/L	17.7
Bilirubin , qual	U	Negative		
Bromsulfophthalein (BSP)	S	< 5% after 45 minutes		
Calcium -total	S	8.7 – 10.5 mg / dl	2.18-2.63mmol/L	0.25
-Ionized	S	4.7 – 5.5 mg / dl	1.18-1.38mmol/L	0.25
Catecholamines, total	U	< 100µg / 24 hr	<0.59 µmol / 24 hr	0.0059
Chloride	S	98 – 108 meq / L	98-108 mmol/L	
	Sf	120 – 132 meq / L	120-132 mmol/L	10
	Sweat	5 – 40 meq /L	5-40 mmol/L	
Cholesterol, total	S	140 – 250 mg / dl but varies with age	3.64-6.50 mmol/L	0.026
CO_2 content	S	Ad24 – 30mmol / L Inf 18 – 26 mmol / L	Same	1.0
Pressure, p CO_2	B	M 34 – 45 mm Hg F 31 – 42 mm Hg		
	P (Art)	M 24 – 30 mm Hg F 21 – 30 mm Hg		
Cortisol	P	6-25 µg /dl	166-690 nmol/L	27.6
Creatine kinase (CK)	S	10-100 U/L	By method described	
Creatine kinase isoenzyme (CK-MB)	S	<6U/L		
Creatinine	S	M0.7-1.4 mg/dl	60-125 µmol/L	88.4
		F0.6-1..3 mg/dl	53-115 µmol/L	
		Ch 0.4-1.2 mg/dl	36-107 µmol/L	
	U	Ad ~1mg/min		
	Af	> 2.0 mg /minTaken as sign of naturiy	>177µ mol/L	

Test	Value			
	Specimen	Conventional	SI units	Factor
Creatinine clearance	S U	M 105 ± 20 ml/min F 97 ± 20 ml/ min		
Electrophoresis	S			
Albumin		3..5-5.2 g/dl	35-52 g/L	10
α_1-globulin		0.1 –0.4 g/dl	1-4 g/L	10
α_2-globulin		0..5 –1.0 g/dl	5-10 g/l	10
ß-globulin		0.6 – 1.2 g/dl	6-12 g/L	10
γ–globulin		0.6 – 1. 6 g// dl	6-16 g/l	10
Estriol (E$_3$), 3rd trimester, Unconjugated Total Estriol (pregnancy)	S S U	5- 40 ng/ml 40-500 ng/ml At term. 14- 44 mg/24 hr	17-140 nmol/L 140-1750 nmol /L 49- 154 μmol /24 hr	3..5 3..5
Gamma glutamyl transferase (GGT)	S	M3 – 35 U/L F3- 30 U/L		
Globulins, total	S	2.3-3.5 g/dl	23-35 g/L	10
Glucose	S Sf	65-100 mg /dl 40-70 mg/ dl	3.6-5.6 mmol/L 2.2-3.9 mmol/L	0.055
Glucose, Qual	U	<10 mg/dl	<0.55 mmol/L	
Growth hormone (GH) (during day	P	~5 ng/ml	~5μg/L	1000
Human chorionic gonadotropin (hCG) Nonpregnancy Pregnancy ß- hCG(nonpregnancy 7- hydroxycorticosteroid s (17-OHCS	S S S U	F0-10 mU/ml F>30mU/ml F< 3mU/ ml Ad 5-14 mg/24 hr	17-48μmol/24hr	3.46±
Iodine, protein- bound (PBI)	S	4.0-8.0 μg/dl	0..32-0.63μ mol/L	0.079
Insulin	P	<860pg/ml	< 860 ng /L	1000
Iron, total	S	65-165μg/dl	11.6-29.5 μmol/L	0.179
Iron binding capacity (TIBC) %Saturation	S	300-400μg/dl 20-50%	53.7-71.6 μmol/L	0.179
17-Ketogenic steroids (17-KGS)	U	M8-25 mg /24 hr F5-18 mg /24 hr Ch 2-4mg/24 hr	28-87 μmol/24hr 17-62 μmol/24hr 9.6-13.8μmol 24 hr	3.46‡

Test		Value		
	Specimen	Conventional	SI units	Factor
17-Ketosteroids (17-KS)	U	M 8-20 mg/24hr F 5-15 mg/24hr Ch <2mg/24hr	28-69µmol/ 24 hr 17-52 µmol 24 hr <6.9 µmol/24 hr	3.49±
Lactate dehvdrogenase (LD)	S	P→L 125-290 U/L	By method described	
Lactate dehvdrogenase isoenzymes	S			
LD1		20-34% of total	<100 U/L	
LD2		32-40% of total	<115 U/L	
LD3		17-23%of total	<65 U/L	
LD4		3-13% of total	<40 U/L	
LD5		4-12% of total	<35 U/L	
Lecithin/sphingomylin (L/S) ratio	Af	>2.0 indicates Maturity		
Lipase	S	28-200 U/L	By method described	
Magnesium	S	1. 3 -2.10meq/L	0.65-1.05 mmol/L	0.5
Metanephrines	U	0.3-0.9 mg/24 hr	1. 5 - 4.6µmol/24hr	5.1
5-Nucleotidase (NTP)	S	0.4-7.0U/L		
Omithine carbamoyl transferase(OCT)	S	0-6U/L		
Osmolality	S	278-305 mosm/kg		
Oxygen content	B	15-23 ml/dl		
Oxygen pressure pO2	B	85-95mm Hg		
Oxygen saturation	B	94-97%		
PH	B(Art)	7.35-7.45		
Phenolsulfonphthalein (PSP)	U	15 min >25%excreted 30 min >40% excreted		
Phosphatase, acid (ACP)total Tartrate inhbitable	S	0.2-1.8 U/L 0.2-0.6 U/L	By method described	
Parathyroid hormone (PTH)	S	0.10-0.65 ng/ml when Ca^{2+} is 1.02-1.16 Mmo/L		
Phosphatase, alkaline (ALP)	S	Ad 20-105 U/L To 3 mo70-220 U/L 3mo-10yr 60-150 U/L 10yr- pub 60-260	By method described	

Test	Value			
	Specimen	Conventional	SI units	Factor
Phosphate, inorganic (as P)	S	Ch4.0-7.0 mg /dl Ad3.0-4 5 mg/dl	1.28-2.24 mmol/L 0 .96-1.44 mmol/L	0.32
Potassium	S	3.8-5.4 meq/L	3.8-5.4 mmol/L	1.0
Protein, total	S Sf U	6.0-8.2 g/dl 15-45 mg/dl <10 mg/dl	60-82g/L 150-450 mg/L <100 mg/L	10
Sodium	S	136-145 meq/L	136-145 mmol/L	1.0
Testosterone	P P	M3.5-1.2 ng/ml F 0..3-0.9 ng/ml	12-12 nmol/L .0-3.1nmol/L	3..5
Thyroid hormones -by RIA	S	As thyroxine 4.1-11.3µg/dl	53-147 nmol/L	13
T_4-free	S	5ng/dl	65pmol/L	13
T_3- free	S	0.6ng /dl	9pmol/L	15
T_3-resin uptake	S	33-40%		
Thyroid stimulating hormone (TSH)	P	0-3µU/ml		
Triglycerides	S	40-150 mg-dl	0.45-1.7 mmol/L	0.0113
Urea nitrogen	S	8-18 mg /dl	2 .9-6.4 mmo/L	0.357
Uric acid	S	M3.5-7.5mg/dl F 2.5-6.5 mg/ dl Ch 2.0-5..5 mg/dl	0.210-0.445mmol 0.150-0.390mmol/L 0.120-0.330 mmol/L	0.060
Urobil nogen 2 hr	U	0.1-1 Ehrlich units	-Arbitrarv unit	
24 hr	U	0.5-4 Ehrlich units		
VMA 4-hydroxv-3-methoxymandelic acid	U	2-8 mg/24 hr	10-10 µmol/24 hr	5.05

S= serum
P= plasma
B= whole blood
U= urine
Sf= spinal fluid

Af= amniotic fluid
qual= qualitative
Art= arterial
Ad= adult
Ch= children

M= adult male
F= adult female
Inf= infant

Greek Letters Commonly Used In Clinical Chemistry

α	Alpha.
β	Beta.
γ	Gamma.
δ	Delta.
κ	Kappa.
λ	Lambda(obsolete term for wavelength, microliter).
Σ	Sigma (sum of).
Δ	Delta (difference).
μ	Mu.

Atomic Weights Of The Common Elements

Name	*Symbol*	*International atomic mass*	*Name*	*Symbol*	*International atomic mass*
Aluminum	Al	26.98	Manganese	Mn	54.94
Antimony	Sb	121.8	Mercury	Hg	200.6
Argon	Ar	39.95	Molybdenum	Mo	95.94
Arsenic	As	74.92	Neon	Ne	20.18
Barium	Ba	137.3	Nikel	Ni	58.71
Beryllium	Be	9.012	Nitrogen	N	14.01
Bismuth	Bi	209.0	Oxygen	O	16.00
Boron	B	10.81	Palladium	Pd	106.4
Bromine	Br	79.91	Phosphorus	P	30.97
Cadmium	Cd	112.4	Platinum	Pt	195.1
Calcium	Ca	40.08	Potassium	K	39.10
Carbon	C	12.01	Selenium	Se	78.96
Cerium	Ce	140.1	Silicon	Si	28.09
Cesium	Cs	132.9	Silver	Ag	107.9
Chlorine	Ci	35.45	Sodium	Na	22.99
Chromium	Cr	52.00	Strontium	Sr	87.62
Cobalt	Co	58.93	Sulfur	S	32.06
Copper	Cu	63.54	Tellurium	Te	127.6
Fluorine	F	19.00	Thallium	Ti	204.4
Gold	Au	197.0	Thorium	Th	232.0
Helium	He	4.003	Tin	Sn	181.7
Hydrogen	H	1.008	Titanium	Ti	47.90
Iodine	I	126.9	Tungsten	W	183.8
Iron	Fe	55.85	Uranium	U	238.0
Lanthanum	La	138.9	Vanadium	V	50.94
Lead	Pb	207.2	Xenon	Xe	131.3
Lithium	Li	6.939	Zinc	Zn	65.37
Magnesium	Mg	24.31			

REFERENCE RANGES

URINE (RANDOM SPECIMEN) REFERENCE RANGES

PHYSICAL EXAMINATION

Component	Result
Color	Colorless to amber (varies with state of hydration, diet, health)
Clarity	Clear
Specific gravity	1.002 to 1.035 (physiologically possible 1.002 to 1.040)
Osmolality	275 to 900 mOsm/kg H_2O (physiologically possible 50 to 1400 mOsm/kg H_2O)
Volume	600 to 1800 mL/d (varies with state of hydration, diet, health)

CHEMICAL EXAMINATION

Component	Result
Bilirubin	Negative
Glucose	Negative
Ketones	Negative
Leukocyte esterase	Negative
Nitrite	Negative
pH	4.5 to 8.0
Protein	Negative
Urobilinogen	≤ 1 mg/dL

MICROSCOPIC EXAMINATION*

Component	Number	Magnification
Red blood cells	0 to 3	Per high-power field
White blood cells	0 to 8	Per high-power field
Casts	0 to 2 hyaline	Per low-power field
Epithelial cells		
Squamous	Few	Per low-power field
Transitional	Few	Per high-power field
Renal	Few	Per high-power field
Bacteria and yeast	Negative	Per high-power field

* *Using the UriSystem for standardized microscopic analysis.*

FECAL REFERENCE RANGES

PHYSICAL EXAMINATION	
Color	Brown
Consistency	Firm, formed
Form	Tubular, cylindrical
CHEMICAL EXAMINATION	
Fat, quantitative (72-hour specimen)	
Total fat	<6 g/d <20% of stool
Osmolality	285 to 430 mOsm/kg H_2O
Potassium	30 to 140 mEq/L
Sodium	40 to 110 mEq/L
MICROSCOPIC EXAMINATION	
Fat, qualitative	
Neutral fat	Few globules present per high-power field
Total fat	<100 fat globules per high-power field Globule diameter: ≤4 microns
Leukocytes (qualitative)	None present
Meat and vegetable fibers (qualitative)	Few

SEMINAL FLUID REFERENCE RANGE

PHYSICAL EXAMINATION	
Appearance	Gray-white, opalescent, opaque
Volume	2.0 to 5.0 mL
Viscosity	Discrete droplets (watery) within 60 minutes
CHEMICAL EXAMINATION	
pH	7.2 to 7.8
Acid phosphatase (total)	≥200 U per ejaculate at 37°C (*p*-nitrophenylphosphate)
Citric acid (total)	≥52 μmol per ejaculate
Fructose (total)	≥13 μmol per ejaculate
Zinc (total)	≥2.4 μmol per ejaculate
MICROSCOPIC EXAMINATION	
Motility	50% or more with moderate to rapid linear (forward) progression
Concentration	20 to 250 $\times 10^6$ spermatozoa/mL
Morphology	50% or more have normal morphology
Viability	50% or more are alive
Leukocytes (white blood cells)	Less than 1 $\times 10^6$/mL

CEREBROSPINAL FLUID REFERENCE RANGE*

PHYSICAL EXAMINATION

Color	Colorless
Clarity	Clear

CHEMICAL EXAMINATION

Component	Conventional Units	Factor	SI Units
Electrolytes			
Calcium	2.0 to 2.8 mEq/L	0.5	1.00 to 1.40 mmol/L
Chloride	115 to 130 mEq/L	1.	115 to 130 mmol/L
Lactate	10 to 22 mg/dL	0.111	1.1 to 2.4 mmol/L
Magnesium	2.4 to 3.0 mEq/L	0.5	1.2 to 1.5 mmol/L
Potassium	2.6 to 3.0 mEq/L	1.	2.6 to 3.0 mmol/L
Sodium	135 to 150 mEq/L	1.	135 to 150 mmol/L
Glucose	50 to 80 mg/dL	0.5551	2.8 to 4.4 mmol/L
Total protein	15 to 45 mg/dL	10.	150 to 450 mg/L
Albumin	10 to 30 mg/dL	10.	100 to 300 mg/L
IgG	1 to 4 mg/dL	10.	10 to 40 mg/L

Protein Electrophoresis	Percentage of Total Protein
Prealbumin	2% to 7%
Albumin	56% to 76%
α_1-Globulin	2% to 7%
α_2-Globulin	4% to 12%
β-Globulin	8% to 18%
γ-Globulin	3% to 12%

MICROSCOPIC EXAMINATION

Leukocyte Count	Conventional Units	Factor	SI Units
Neonates (<1 year old)	0 to 30 cells/μL	10^6	0 to 30 × 10^6 cells/L
1 to 4 years old	0 to 20 cells/μL	10^6	0 to 20 × 10^6 cells/L
5 to 18 years old	0 to 10 cells/μL	10^6	0 to 10 × 10^6 cells/L
Adults (>18 years old)	0 to 5 cells/μL	10^6	0 to 5 × 10^6 cells/L

Differential Cell Count	Percentage of Total Protein
Neonates	
Lymphocytes	5% to 35%
Monocytes	50% to 90%
Neutrophils	0% to 8%
Adults	
Lymphocytes	40% to 80%
Monocytes	15% to 45%
Neutrophils	0% to 6%

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* *For cerebrospinal fluid specimens obtained by lumbar puncture.*

AMNIOTIC FLUID REFERENCE RANGES

PHYSICAL EXAMINATION	
Color	Colorless to pale yellow
Clarity	Clear to slightly turbid*
CHEMICAL EXAMINATION	
ΔA_{450} determination	
27 weeks' gestation	<0.065
30 weeks' gestation	<0.052
35 weeks' gestation	<0.035
40 weeks' gestation	<0.022
Lecithin/sphingomyelin ratio (mature)	>2.0

* *The amount of turbidity increases with gestational age.*

SYNOVIAL FLUID REFERENCE RANGE*

PHYSICAL EXAMINATION	
Total volume	0.1 to 3.5 mL
Color	Pale yellow
Clarity	Clear
Viscosity	High, forms strings 3 to 6 cm long
Clots spontaneously	No
CHEMICAL EXAMINATION	
Glucose	Equivalent to plasma values†
Uric acid	Equivalent to plasma values†
Total protein	1 to 3 g/dL
Lactate	9 to 33 mg/dL**
Hyaluronate	0.3 to 0.4 g/dL
MICROSCOPIC EXAMINATION	
Erythrocyte count	<2000 cells/μL
Leukocyte count	<200 cells/μL
Differential cell count	
Monocytes and macrophages	Approximately 60%
Lymphocytes	Approximately 30%
Neutrophils	Approximately 10%
Crystals	None present

* *Values given are for fluid obtained from the knee.*

† *Synovial fluid values are equivalent to plasma values if obtained from a fasting patient.*

** *Normal lactate values are assumed to be similar to those of blood and cerebrospinal fluid; actual reference intervals have yet to be established (Kjeldsberg CR, Knight JA: Synovial fluid. In Body Fluids (2nd ed.), Chicago, American Society of Clinical Pathologists Press, 1986, pp. 129–152).*